



PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: BAYER -3 PCT

SERIAL NO.: 10/049,173 EXAMINER: ROGER PANG

FILED: FEBRUARY 8, 2002 GROUP: 3681

TITLE: PLANETARY TRANSMISSION

DECLARATION UNDER RULE 132

MAIL STOP AMENDMENT  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

I, THOMAS BAYER, declare as follows:

that I am the sole inventor of the invention described and claimed in U.S. Patent Application Serial No. 10/049,173, filed February 8, 2002 for the invention titled "PLANETARY TRANSMISSION";

that I have the following academic and employment credentials:

I studied mechanical engineering at a German, recognized, excellent technical university, and graduated as a Dipl.-Ing. (FH) [Graduate in Engineering from this technical university, equivalent to M.S. in Engineering]; that eleven years ago, I became Head of Design at the company Alpha Getriebbau GmbH; that Alpha Getriebbau GmbH is a manufacturer of planetary gear drives, in particular, specifically mainly precision drives, and

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is known worldwide; that since one year ago, I have been Director of Research and Strategic Development of this company; that since six years ago, I have been a member of the Scientific Advisory Board of the Germany Research Association for Drive Technology; that this research association has a good reputation among persons skilled in the art and is recognized worldwide; that in particular, I am considered to be an expert on planetary gear drives, among persons skilled in the art in Germany and European countries that border on Germany; that because of the worldwide activities of Alpha Getriebbau GmbH, I am also very familiar with planetary gear drives on all world markets, particularly Japan and the United States;

that I have read and understood the Nonfinal Office Action dated April 2, 2004, which was received in the above-identified Patent Application;

that I have read and understand the two prior art references, which are the *Ridgely U.S. Patent No. 2,591,967*, and the *Shirokoshi DE 198 40 968* which were applied by the Patent Examiner in this Nonfinal Office Action;

that according to the current claims 8 and 9, the invention, briefly summarized, relates to a

3-stage planetary gear mechanism having a tooth number of all the internal geared wheels of 108 and the following particular features in the 2<sup>nd</sup> and 3<sup>rd</sup> stage  
2<sup>nd</sup> stage: 4 planets

$$i = 4$$

3<sup>rd</sup> stage: 4 planets

$$i = 5.5$$

with  $i$  = translation ratio in one stage

That in the background of the invention and in the case of planetary gear mechanisms, there are generally valid design guidelines with reference to the following parameters. These parameters include the tooth number of an internal geared wheel, the number of planets in a gear stage, and the number of possible whole-number translations that can be achieved in a gear stage. These generally known design guidelines are shown in Diagram No. 1. From this, it is clearly evident that in the case of a tooth number of 108 in the internal geared wheel of a gear stage, and three planets, for example, the greatest number of different possible whole-number (integral number) translations, namely 5, can be achieved. The number of possible whole-number translations means that according to the diagram, at an internal geared wheel tooth number of 108 and three planets, a maximum of five whole-number translations can be achieved. This knowledge

is part of the general state of the art. This leads to the result that in practice, internal geared wheels with the tooth number 108 are preferably used. This is done in order to thereby achieve a great variability of possible whole-number translations that can be achieved. In the case of an internal geared wheel tooth number of  $Z = 108$  and 4 planets, there is merely a single whole-number translation, according to the information in this Diagram No. 1.

That in Diagram No. 2, the number of whole-number translations is plotted on the abscissa, and the number of planets that can be used in a gear stage is plotted on the ordinate. Corresponding to Diagram No. 1, a total of five whole-number translations is possible in the case of three planets in a gear stage, specifically with  $i = 3, 4, 5, 7$ , and 10. This gain applies with reference to an internal geared wheel having 108 teeth. In the case of four planets in a gear stage, only a whole-number translation ratio with  $i = 4$  is possible. In this regard, the content of Diagram No. 2 is also part of the generally known state of the art.

A person skilled in the art of gear mechanisms understands the state of the art on this basis. In practice, fundamentally, whole-number translation ratios between the input and the output

are generally desired in gear mechanisms. Thus, a person skilled in the art will generally utilize only whole-number translation ratios in the individual gear stages, exclusively, in each instance. Because to do otherwise, the demand for a whole-number translation ratio number that can be achieved by the gear mechanism overall cannot be met.

The present invention proceeds from this general state of the art as described above. In other words, the present invention describes an improvement upon the technical knowledge of a gear mechanism designer.

In an effort to obtain the greatest possible torque at also the greatest possible translation ratio, with the smallest possible planetary gear mechanism and the fewest possible gear stages, the inventor investigated the following. It was investigated whether it might be possible to also achieve non-whole-number translation ratios in a gear stage having three or four planets, under the conditions illustrated in Diagram No. 2. In this regard, the inventor found that in the case of a gear mechanism having three planet gears in a stage, other than the previously known five whole-number translation ratios known before the present invention, it was only possible to implement a single other non-whole-number translation ratio with  $i = 5.5$ ,

which can be implemented in terms of structure.

In the case of a gear stage having four planet gears, the inventor determined two additional non-whole-number translation ratios as being possible to achieve by his analysis, specifically the translation ratios  $i = 3.25$  and  $i = 5.5$ .

Completely in contrast to the technical knowledge of a gear mechanism designer of ordinary skill in the art that is usually practiced, the inventor conceived of the present invention. This was accomplished through an investigation of whether the use of a non-whole-number translation ratio of 5.5, for example, in a gear stage having 3 or 4 planet gears, with a planetary gear mechanism having a total of three stages, would make it possible to achieve unexpected results. An unexpected improvement was made as compared with the generally known state of the prior art, specifically with reference to a higher torque to be transferred. In this regard, the inventor was aware of the practical constraint that he can only make available a gear mechanism with which a whole-number translation between the input and the output can be achieved. Other gear mechanisms would not fall within the general practical standard, and would therefore not find any utility for those skilled in the art.

In order to be able to achieve the requirements of a whole-number translation ratio to be produced, in total, by the three-stage gear mechanism, the inventor investigated what total translation ratio can be achieved at the output of a second gear stage that follows a first gear stage. In this regard, in the case of a three-stage gear mechanism, the aforementioned first stage would be the second stage, and the aforementioned second stage would be the third stage, and therefore the last stage.

Diagram No. 3 shows the total translation ratios that can be achieved in two consecutive stages of a gear mechanism if a translation ratio has already been achieved in the previous stage. The total translation ratio of such a gear mechanism therefore results from a multiplication of the translation ratio of the previous stage and the translation ratio of the following stage. In Diagram No. 3, the translation ratio of the previous stage, with which a transition into the following stage takes place, is plotted on the ordinate, while the translation ratio that can be achieved in the following stage is plotted on the abscissa. In the diagram, all possible translation ratios that can be combined with one another in construction terms are entered for those plotted on the abscissa and the ordinate. In this regard, only a total of nine translation ratios that can be implemented by analysis are obtained. A particularly high whole-

number translation ratio, with a total translation ratio of  $i = 4 \times 5.5 = 22$ , is demonstrated by a combination of a translation ratio of  $i = 4$  in the front stage and  $i = 5.5$  in the following stage. With reference to the invention, the "front" gear stage corresponds to the second (next-to-last) stage of the three-stage gear mechanism there, and the "following" gear stage corresponds to the third and therefore last gear stage (power take-off stage of the gear mechanism).

This results in the first essential inventive step in the case of a three-stage gear mechanism, that of selecting the translation ratio in the next-to-last gear stage as 4, and in the last gear stage as 5.5, in order to thereby obtain a relatively higher whole-number translation ratio, in total of 22. The actual, fully surprising advantage that can be achieved with the invention is shown by Diagram No. 4.

In this Diagram No. 4, different translation ratios are plotted on the abscissa, and the torque that can be achieved is plotted on the ordinate, as a percent of a maximum torque (100%) that can maximally be achieved at a specified translation ratio. A maximum torque that can be achieved in a gear stage having an internal geared wheel with 108 teeth and three or four planet gears can be achieved at a translation ratio of  $i = 5.5$ .

The decrease in the torque that can be achieved at other translation ratios is very clearly illustrated by Diagram No. 4. This recognition of how the highest possible torque can be achieved on the power-take-off side of a two-stage planetary gear mechanism, surprisingly resulted from the inventive discovery by the inventor. This is in contrast to what was previously known in the art of gear mechanisms, because the present invention also included non-whole-number translation ratios in the inventor's analysis and calculations, and structure produced.

Furthermore, the inventor was able to find that in a gear stage having four planet gears, as compared with a gear stage having only three planet gears, a significantly greater maximum (135%) torque can be achieved. The related increase in the torque is shown in Diagram No. 5, by means of a comparison of the ratios for three (100%) and four (135%)planet gears in a gear stage, wherein  $i=5.5$ . This increase in load capacity from 100% for three planet gears up to 135% for four planet gears at  $i=5.5$  and with 108 teeth internal gear was totally unexpected and was unpredictable.

As the above explanations clearly and convincingly show, the inventor was able to achieve an unexpectedly, surprisingly beneficial result, in total, with the combination of individual,

specific gear mechanism parameters he selected, namely the number of planet gears and the translation ratios to be selected in the individual gear stages, with internal geared wheels having a tooth number of 108, in each instance. This result is based on inventive activity particularly because the inventor did not choose only whole-number partial translation ratios in the individual stages, as is generally known, because a whole-number translation ratio is to be achieved between the input and output of a three-stage gear mechanism, in total. Instead, the inventor, in a completely different manner, also discovered possible non-even-number translation ratios, and thoroughly investigated the resulting consequences and possibilities.

I further declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false<sup>4</sup> statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may

jeopardize the validity of the application or any patent issuing thereto.

Date:

29.11.04



The image shows a handwritten signature in black ink, which appears to read "Thomas Bayer". The signature is fluid and cursive, with a large, stylized 'T' at the beginning. A thin diagonal line extends from the end of the signature towards the right edge of the page.

THOMAS BAYER

Enclosures: Diagrams 1 to 5

Declaration under Rule 132

diagram 1

possible ratios with integer value

$Z = -108$  most numbers of ratio  
with integer value possible

3 planet gears

4 planet gears

number of possible ratios with integer value

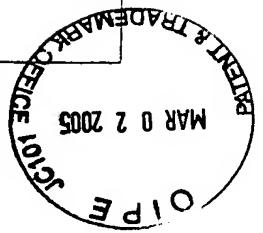
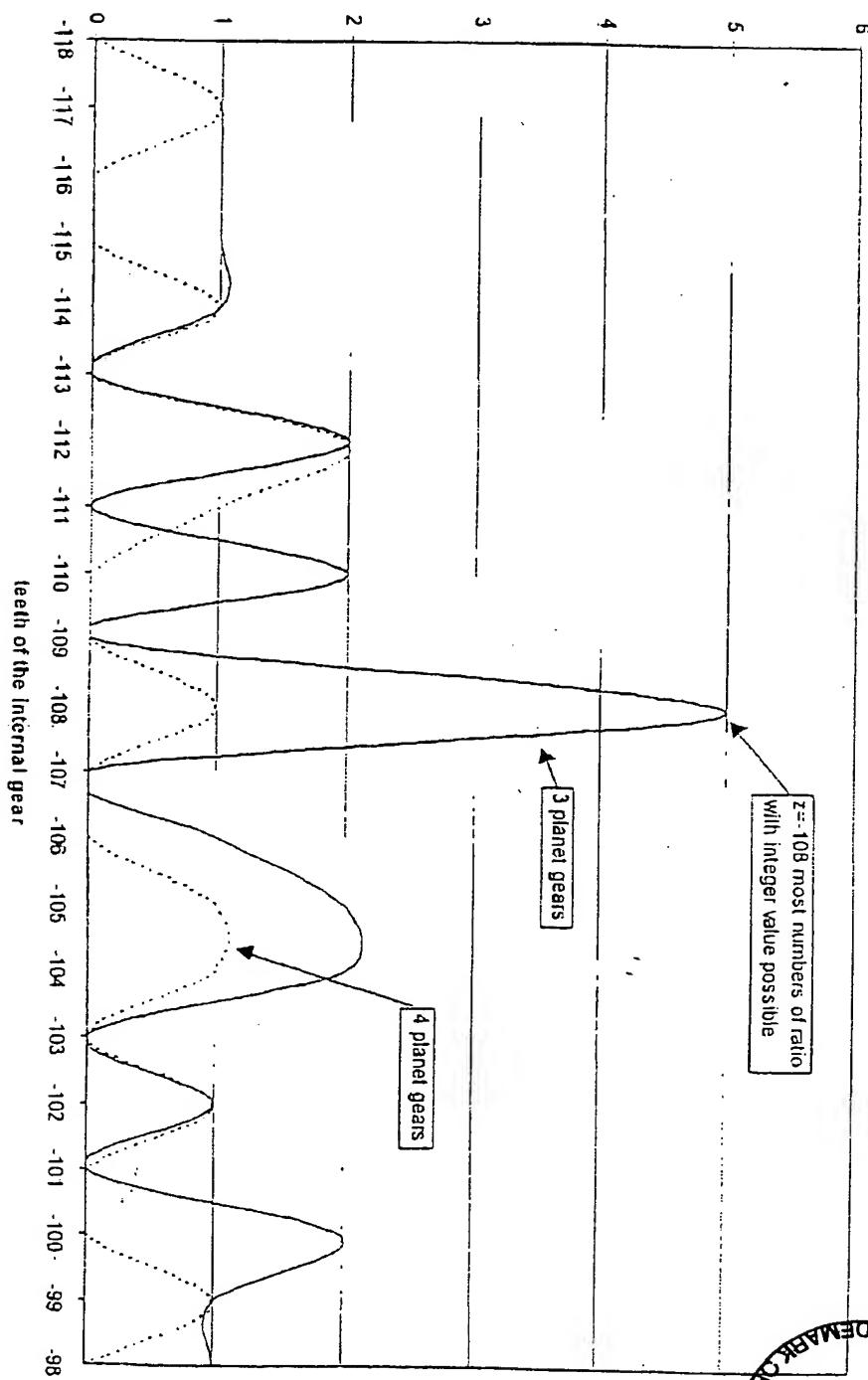


diagram 2

possible ratios with 108 teeth internal gear

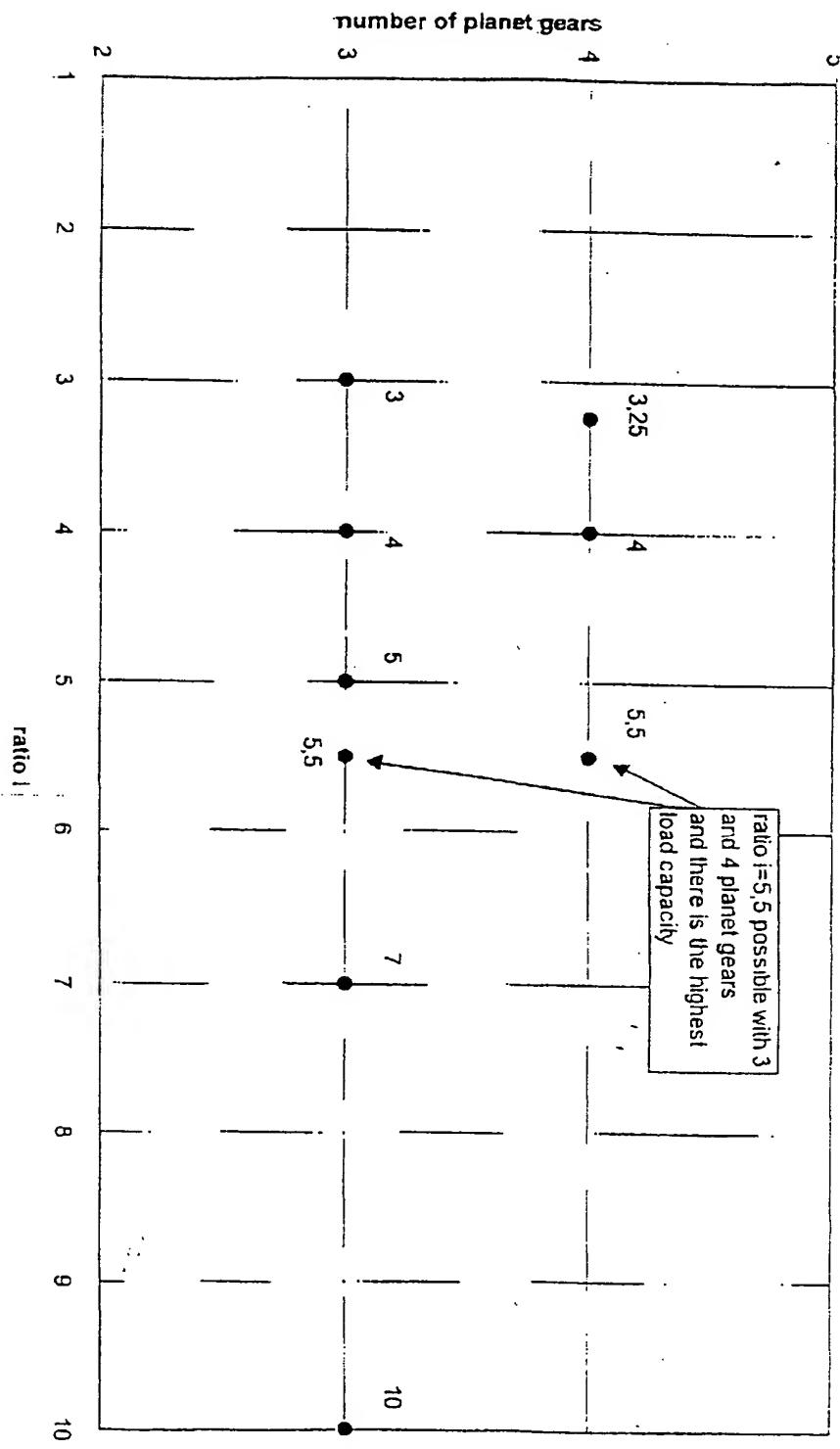
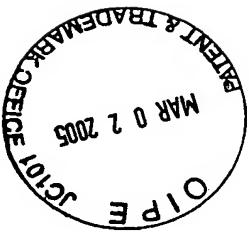


diagram 3

possible two stage ratios with 4 planet gears

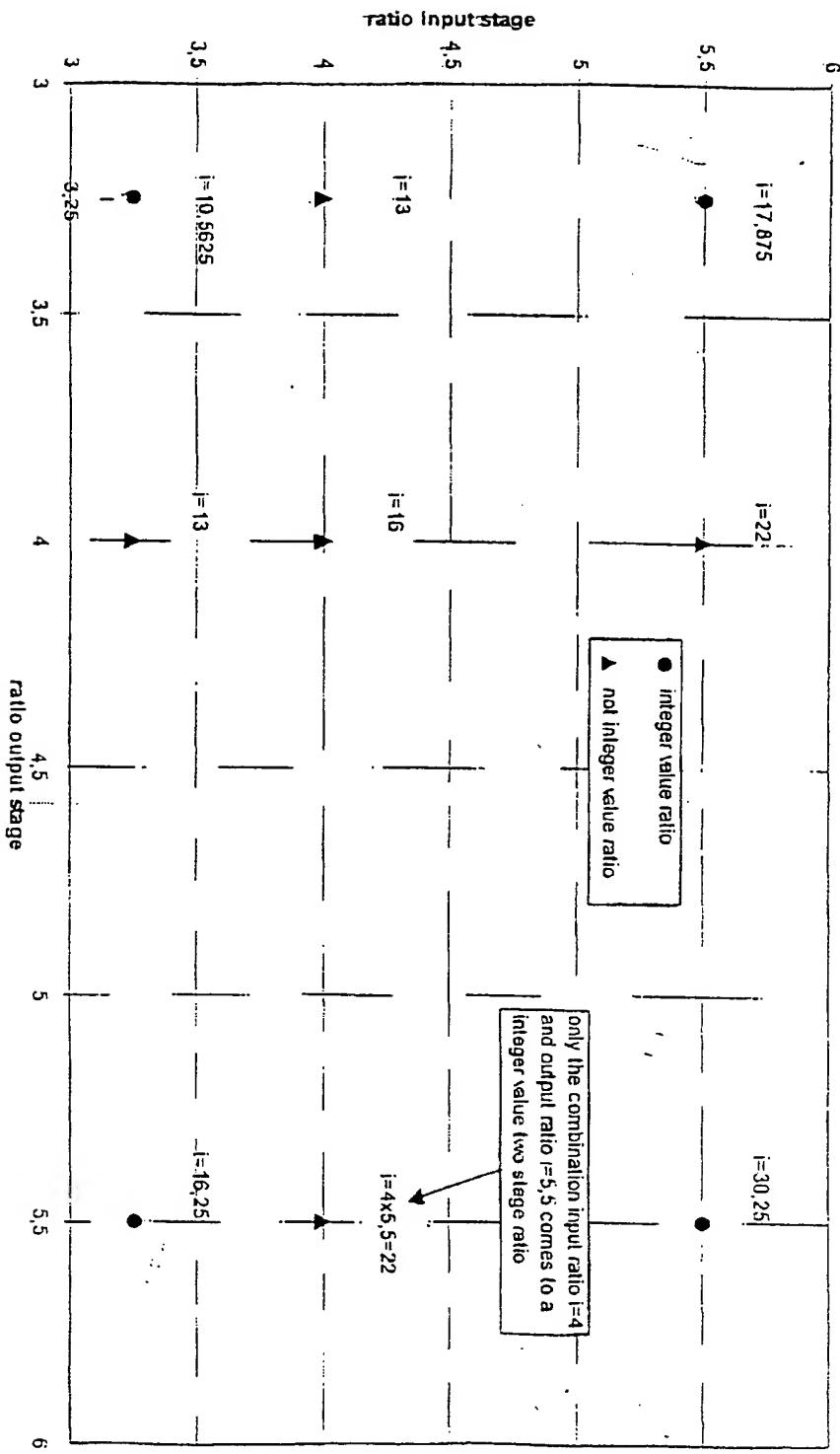
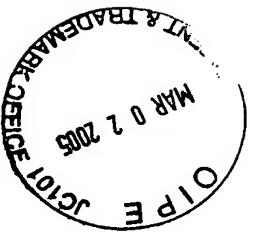


diagram 4

load capacity of different ratios  $i$  with 3 planet gears

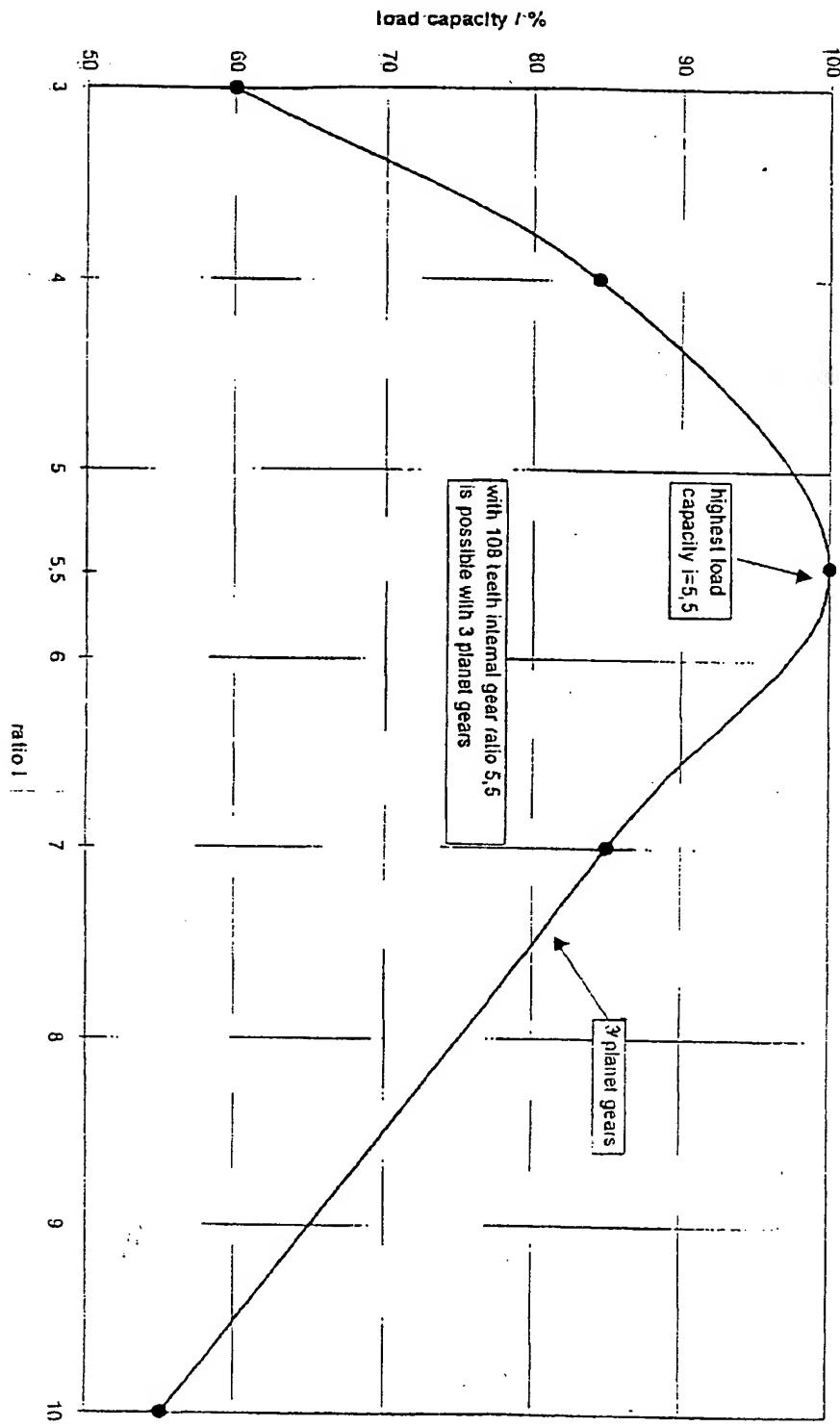
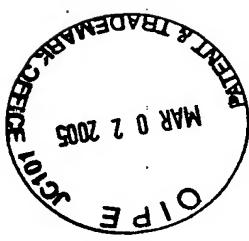
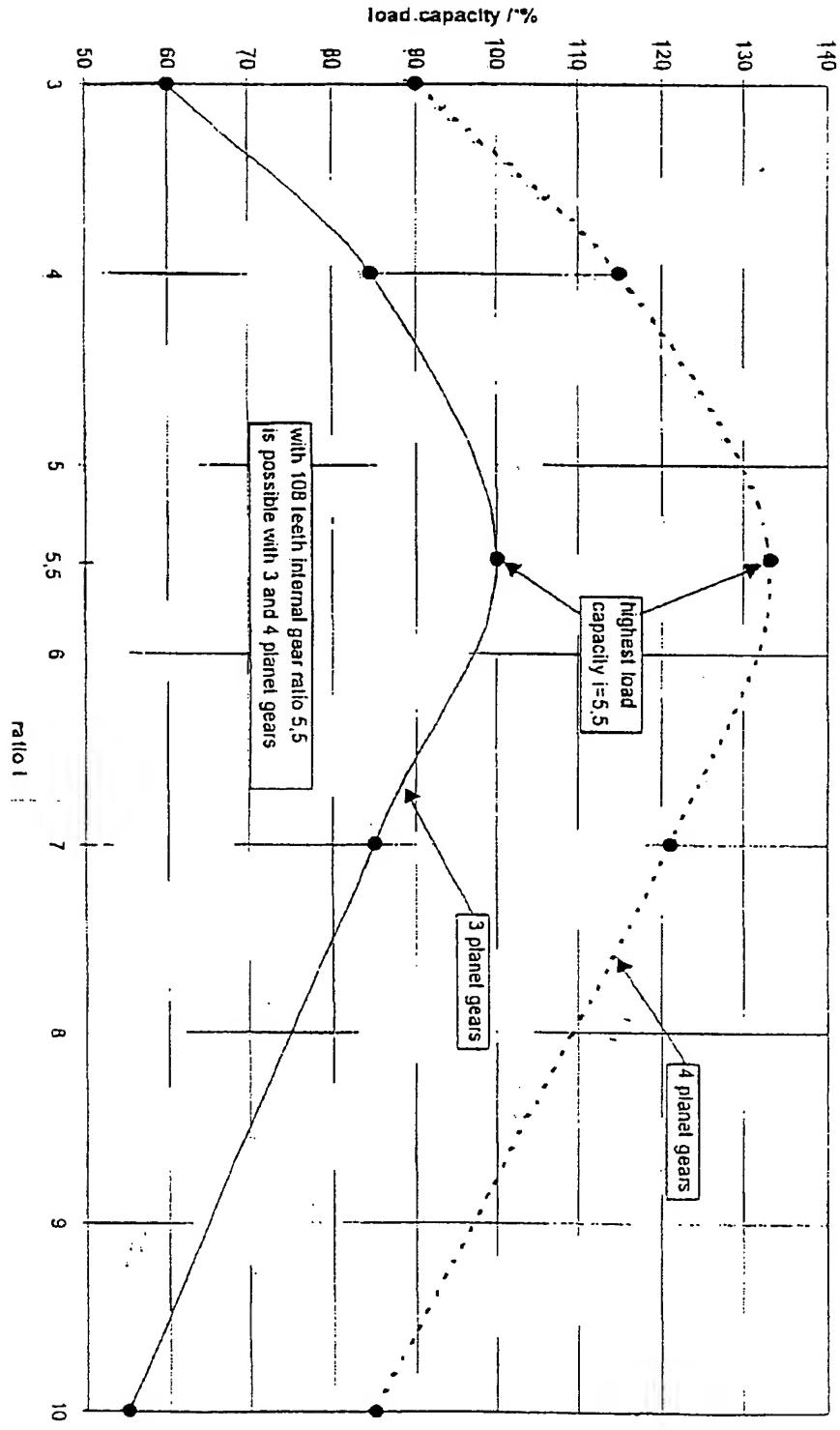


diagram 5

load capacity of different ratios | with 3 and 4 planet gears



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